Long Term Resource Monitoring Program

Program Report
2000-P003

1998 Annual Status Report

Status and Trend of Submersed and Floating-leaved Aquatic Vegetation in Thirty-two Backwaters in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

June 2000

The Upper Midwest Environmental Sciences Center issues LTRMP Program Reports to provide Long Term Resource Monitoring Program partners with programmatic documentation, procedures manuals, and annual status reports.

Cover graphic by Mi Ae Lipe-Butterbrodt

1998 Annual Status Report

Status and Trend of Submersed and Floating-leaved Aquatic Vegetation in Thirty-two Backwaters in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

by

Yao Yin, Heidi Langrehr, John Nelson,
Theresa Blackburn, Thad Cook, Walter Popp, and Jenny Winkelman

June 2000

U.S. Geological Survey
Upper Midwest Environmental Sciences Center
2630 Fanta Reed Road
La Crosse, Wisconsin 54603

Suggested citation:

Yin, Y., H. Langrehr, J. Nelson, T. Blackburn, T. Cook, W. Popp, and J. Winkelman. 2000. 1998 annual status report: Status and trend of submersed and floating-leaved aquatic vegetation in thirty-two backwaters in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, June 2000. LTRMP 2000-P003. 21 pp. + Appendixes A–B.

Additional copies of this report may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (1-800-553-6847 or 703-487-4650). Also available to registered users from the Defense Technical Information Center, Attn: Help Desk, 8725 Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218 (1-800-225-3842 or 703-767-9050).

Contents

Tables

Figures

Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Upper Midwest Environmental Sciences Center (UMESC), a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers and river managers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report presents the results of aquatic vegetation transect surveys conducted in 1998 by field station personnel under direction of the UMESC. Selected areas in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool on the Illinois River were surveyed. This report satisfies, for 1998, Task 2.2.4.6, *Evaluate and Summarize Annual Present-day Results* under Goal 2, *Monitor Resource Change* of the Operating Plan (U.S. Fish and Wildlife Service 1993). The purpose of this report is to provide a summary of data regarding the distribution and abundance of submersed aquatic vegetation collected from the field stations for 1998. This report was developed with funding provided by the Long Term Resource Monitoring Program.

1998 Annual Status Report

Status and Trend of Submersed and Floating-leaved Aquatic Vegetation in Thirty-two Backwaters in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

by

Yao Yin[1]
Department of Ecology and Evolutionary Biology, University of Tennessee
Knoxville, Tennessee 37996

Heidi Langrehr
Wisconsin Department of Natural Resources, Onalaska Field Station, 575 Lester Avenue
Onalaska, Wisconsin 54650

John Nelson[2]
Illinois Natural History Survey, Alton Field Station, 8450 Montclair Avenue
Brighton, Illinois 62012

Theresa Blackburn
Iowa Department of Natural Resources, Mississippi River Monitoring Station, 206 Rose Street
Bellevue, Iowa 52031

Thad Cook
Illinois Natural History Survey, Havana Field Station, 704 North Schrader Avenue
Havana, Illinois 62644

Walter Popp and Jenny Winkelman
Minnesota Department of Natural Resources, Lake City Field Station, 1801 South Oak Street
Lake City, Minnesota 55041

Abstract: Thirty-two backwaters of the Upper Mississippi and Illinois Rivers were monitored for the eighth consecutive year in 1998 to determine the status and trend of changes of submersed and floating-leaved aquatic vegetation. Aquatic vegetation was sampled at regularly spaced sites along previously established permanent transects. Species compositions, frequencies of individual species, and the frequencies of sites that supported aquatic vegetation in 1998 were calculated and compared with results from previous years. The status and trend of aquatic vegetation in 1998 varied among the thirty-two backwaters. In upper Pool 4 (above Lake Pepin), where aquatic vegetation has declined since 1991, the trend continued in 1998. In lower Pool 4 (below Lake Pepin), where aquatic vegetation declined from 1991 to 1996 and started to rebound in 1997, the rebound continued in 1998. Aquatic vegetation has increased in Pools 8 and 13 since 1994 and is at or near its best (recorded) condition since 1991. In recent years, especially since a devastating flood in 1993 and through 1998, aquatic vegetation has been rare in La Grange Pool (Illinois River) and Pool 26. In Pool 26, however, aquatic vegetation was found in all four backwaters surveyed in 1998–three of the four had no aquatic vegetation in 1997. Similarly, aquatic vegetation was found in three of the four backwaters surveyed in La Grange Pool in 1998–one of the three had no aquatic vegetation in 1997.

Key words: Annual report, aquatic, floating-leaved, LTRMP, Mississippi River, submersed, vegetation

---

[1]Present address: U.S. Geological Survey, Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Road, La Crosse, Wisconsin 54603

[2]Present address: Illinois Department of Natural Resources, Moraine Hills State Park, 914 South River Road, McHenry, Illinois 60050

Introduction

Aquatic vegetation in the Upper Mississippi River System (UMRS) has been monitored as part of the Long Term Resource Monitoring Program (LTRMP) since 1989. The 1998 growing season is the eighth consecutive year aquatic vegetation was monitored in selected backwaters for LTRMP. A report to summarize each year's data is a Program requirement, and this report satisfies the requirement for 1998 (U.S. Fish and Wildlife 1993).

The sampling scheme is referred to as transect sampling because sampling is conducted along permanent transects. The objective of the transect sampling is to reveal the status and trend of changes of the aquatic vegetation in the UMRS backwaters. This annual report provides basic data summaries, including the species composition of aquatic vegetation, species frequencies of presence, and the frequencies of presence of submersed or floating-leaved aquatic vegetation in individual backwaters.

Historical Perspective

Illinois River

A detailed description of the geological history and changes during the past 2 centuries of the Illinois River is in Bellrose et al. (1979) and Mills et al. (1966). The Illinois River has numerous backwater lakes, many of them expansive. Until the beginning of the 20th century, the backwaters were high-quality, near-pristine habitats for aquatic plants. A sequence of overlapping catastrophic events, however, drastically reduced and degraded the river's natural habitats.

Before 1900, a series of low-head dams were built at Marseilles, Henty, Copperous Creek, La Grange, and Kampsville. On January 1, 1900, completion of the Chicago Sanitary and Ship Canal allowed for diversion of water from Lake Michigan, washing sewage downstream and raising water levels along the Illinois by several feet. Subsequently, the river and its backwaters were severely polluted. Beginning in the 1900s, backwaters were isolated from the river with levees and dewatered for agriculture. This, coupled with completion of the locks and dams from Dresden Heights to La Grange in the 1930s, added to the alteration of the river and its floodplain. Submersed aquatic plants began to disappear from the river as early as 1915 (Richardson 1921). Aquatic and marsh vegetation all but disappeared from the Illinois River during the period between 1920 and 1952.

Pollution from sedimentation presently is more troublesome than urban and industrial pollution because the former is cumulative. Storage capacity within the remaining bottomland lakes along the Illinois has been greatly reduced because of sedimentation. No new backwaters are being formed because of levees and other structures in and along the rivers. Many of the remaining backwaters are controlled to various degrees by levees, water gates, and water pumps. The hydrograph of the modern river is much more spiky and erratic than that of the natural river. Although water quality has improved over the last 20 years, sizable vegetation beds are still rare.

Upper Mississippi River

In contrast with the Illinois River, the Upper Mississippi River harbors more extensive submersed aquatic vegetation now than it did under natural (preconstruction) conditions. Before the 1930s, when the river was not impounded, most of the backwaters and marshes were flooded in spring and dried out in summer and fall. Water-level fluctuations and seasonal drying periods limited the development of aquatic plants in the backwaters (Green 1947). During the 1930s, a series of low-head dams were constructed to raise the water level during low discharges so a 9-foot-deep (minimum) navigation channel could be maintained. The impoundment of the river has created, and since maintained, additional backwater and marsh areas.

Aquatic plants initially prospered because water levels were more stable. Sustaining the quantity and quality of aquatic areas in the Upper Mississippi River, however, is a matter of concern for a number of reasons. Structures have altered the scouring and deposition dynamics of the natural river, which

will likely inhibit the formation of new backwater areas. Bathymetric diversity in the impounded areas is declining and commercial towboat and recreational watercraft traffic is predicted to increase. Consequently, water turbidity may be increased by amplified wind-fetch effect. The LTRMP was created in response to these and other concerns (Rasmussen and Wlosinski 1988). Identifying the trends of changes of the UMRS biological resources is one of the primary goals of the LTRMP (U.S. Fish and Wildlife Service 1993).

Study Areas

The LTRMP has six trend analysis areas, referred to herein by the navigation pool designations according to the U.S. Army Corps of Engineers lock and dam system. They are Pools 4, 8, 13, and 26 and the Open River on the Mississippi River and La Grange Pool on the Illinois River (Figure 1). Pool 26 also includes 12 miles of the lower Illinois River upstream of its confluence with the Mississippi River. The backwaters selected for aquatic vegetation monitoring are distributed in five of the six LTRMP trend analysis areas. The Open River LTRMP trend analysis area is not included in aquatic vegetation monitoring because it lacks any sizable backwaters or stable aquatic vegetation beds connected with the river.

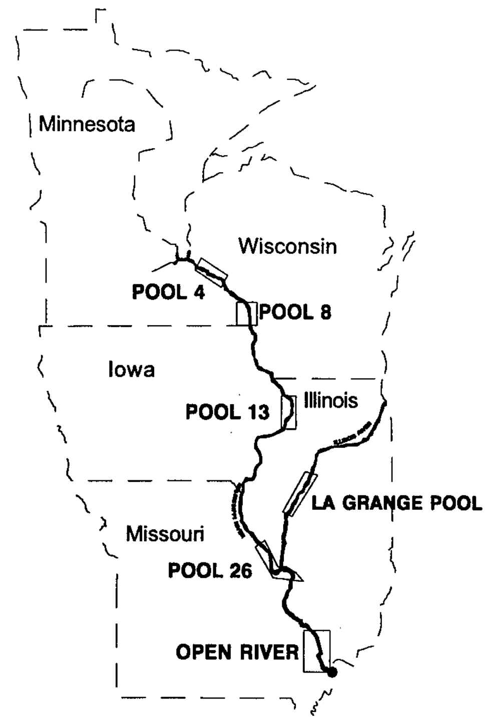

Figure 1. Location of Navigation Pools 4, 8, 13, and 26 and La Grange Pool in the Upper Mississippi River System where aquatic vegetation was surveyed, Long Term Resource Monitoring Program, 1998.

Seven backwaters were surveyed in Pool 4 in 1998 (Figure 2). Dead Slough Lake, Goose Lake, Mud Lake, and Catherine Pass (referred to as Bay City Flats in reports of monitoring before 1995 [Rogers et al. 1998; Appendix A]) are upstream of Lake Pepin. (Lake Pepin is a large tributary delta lake created by the deposition of vast amounts of sand at the confluence of the Chippewa and Mississippi Rivers, near the center of Pool 4.) The other three backwaters, Robinson Lake, Peterson Lake, and Big Lake are below Lake Pepin. Big Lake consists of a complex of smaller backwaters where three clusters of transects were established, including one cluster in Rice Lake and another in Big Lake Bay. Because Rice Lake and Big Lake Bay are similar in habitat conditions and differ from the rest of Big Lake, and because sample sizes from the two areas are individually small, Rice Lake and Big Lake Bay are treated as one backwater separate from the rest of Big Lake: Rice Lake–Big Lake Bay. The transects in Peterson Lake were also divided into Lower and Upper Peterson Lake groups and treated as two separate backwaters. All seven backwaters have been surveyed every year since 1991. In addition to the seven backwaters, Upper Mud Lake was surveyed from 1993 to 1996. Surveying of Upper Mud Lake was discontinued in 1997 because it is semi-isolated and atypical of backwaters in upper Pool 4 and access and sampling became excessively difficult. Consequently, the transects in Pool 4 were grouped into nine backwaters in analysis and reporting. A Habitat Rehabilitation and Enhancement Project (HREP), which involved dredging part of Big Lake Bay, was completed in spring 1993. Construction of an HREP in Peterson Lake in fall 1995 required relocating the first transect downstream about 30 m.

Eight backwaters were surveyed in Pool 8 in 1998 (Figure 3). Target Lake, Lawrence Lake, a backwater near Goose Island (herein referred to as the Goose Island backwater), and Shady Maple are all backwaters contiguous to the main channel

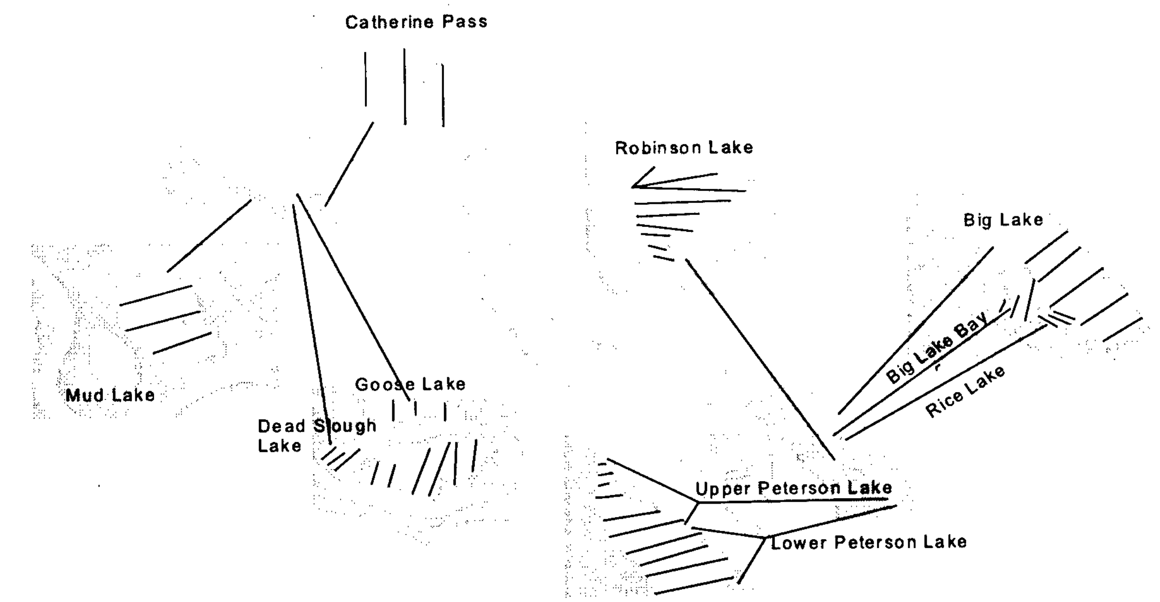

Figure 2. Location and arrangement of transects in Pool 4 (Upper Mississippi River) in 1998.

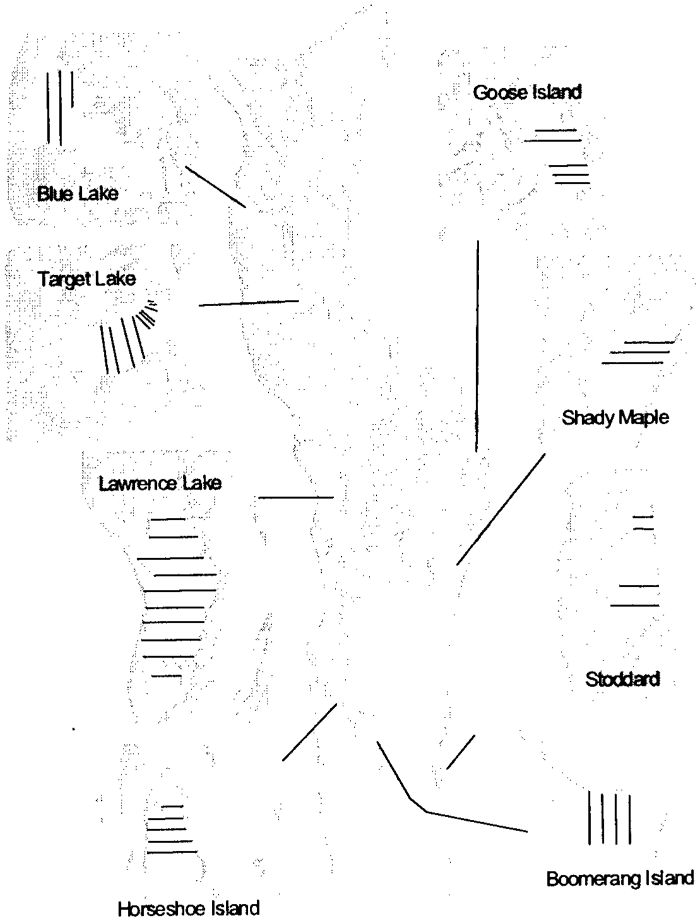

Figure 3. Location and arrangement of transects in Pool 8 (Upper Mississippi River) in 1998.

(Appendix A). Blue Lake and a backwater near Stoddard, Wisconsin (herein referred to as the Stoddard backwater), are isolated from the main channel. Transects established in the interior of Horseshoe and Boomerang Islands are in the impounded area of Pool 8. Target Lake, Lawrence Lake, Goose Island backwater, Shady Maple, and Horseshoe Island have been surveyed every year since 1991. The Stoddard backwater was added in 1992 and Blue Lake and Boomerang Island were added in 1993. Horseshoe Island and Boomerang Island are part of the Pool 8 Islands HREP.

Seven locations were surveyed in Pool 13 in 1998 (Figure 4). Brown's Lake, Savanna Bay, and Spring Lake are contiguous with the main channel, whereas Pomme de Terre, Potter's Marsh, Johnson Creek, and Johnson Creek Levee are in the impounded areas of Pool 13 (Appendix A). Brown's Lake and Potter's Marsh are HREP sites begun in 1988 and 1994, respectively. Transects in all seven locations were established in 1991. Both spring and summer sampling periods in 1998 were characterized by frequent

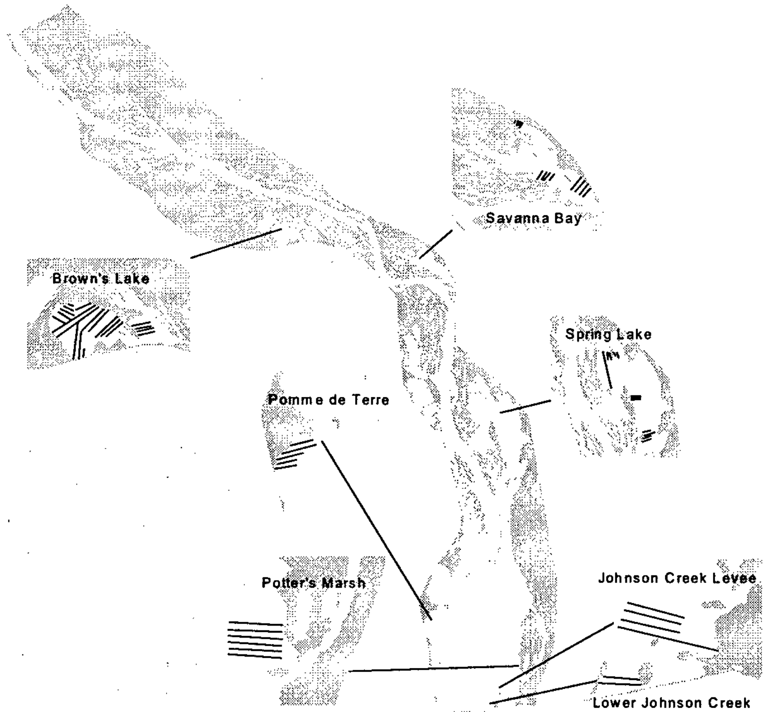

Figure 4. Location and arrangement of transects in Pool 13 (Upper Mississippi River) in 1998.

severe storms and mild temperatures. A 1-foot drawdown in the lower pool was begun 19 June, but was lost 3 July because of high flow conditions (flows greater than 110,000 cfs). It was restarted 11 July but was halted because of low flow conditions (flows less than 50,000 cfs).

Four backwaters were surveyed in Pool 26, which includes portions of both the Mississippi and lower Illinois Rivers (Figure 5). The four backwaters surveyed are in the lower 12 miles of the Illinois River. Fuller Lake, Calhoun Point, and Stump Lake are isolated from the flow of the Illinois River and are managed as moist soil units (mainly to mimic preimpoundment conditions). The Calhoun Point area consists of several backwater lakes, sloughs, and ephemeral ponds. The fourth backwater, Swan Lake, is a large shallow area contiguous with the Illinois River. Although not presently managed as a moist soil unit, Swan Lake is difficult to access during low water levels in the summer. Also, Swan Lake was undergoing HREP modifications, including a levee system that will convert this backwater to noncontiguous status. The levees and pumps will allow for moist soil unit management after 1998. Stump and Fuller Lakes were not sampled during summer 1998 because of low water levels. The Calhoun Point, Stump Lake, and Swan Lake transects were all established in 1991 (Appendix A). Fuller Lake was added in 1992.

Four backwaters were surveyed in La Grange Pool in 1998 (Figure 6; Appendix A). Banner Marsh and Spring Lake have been completely isolated from the flow of the Illinois River by agricultural levees for at least 5 decades. Point Lake is separated from the Illinois River by agricultural levees that have been overtopped frequently by flooding water. The Grape Island location is a main channel border area and therefore directly affected by the river's flow. Banner Marsh was being modified as part of an HREP. Transects in Spring Lake, Point Lake, and Banner Marsh were established in 1991. Grape Island has been surveyed every year since 1992.

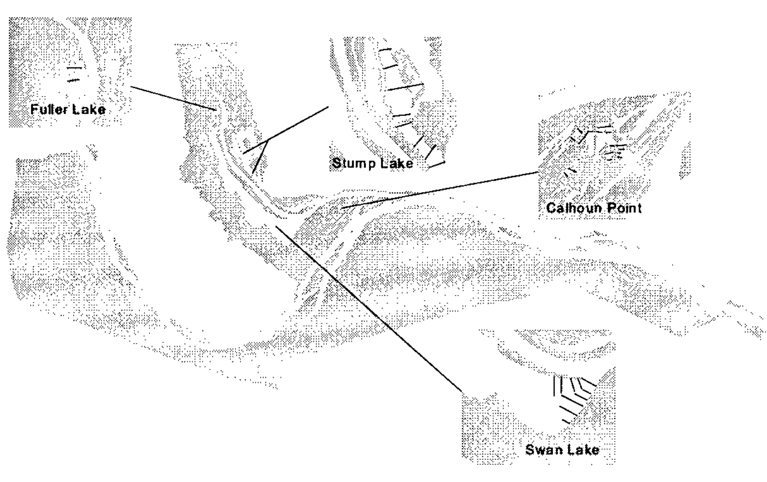

Figure 5. Location and arrangement of transects in Pool 26 (Upper Mississippi and Illinois Rivers) in 1998.

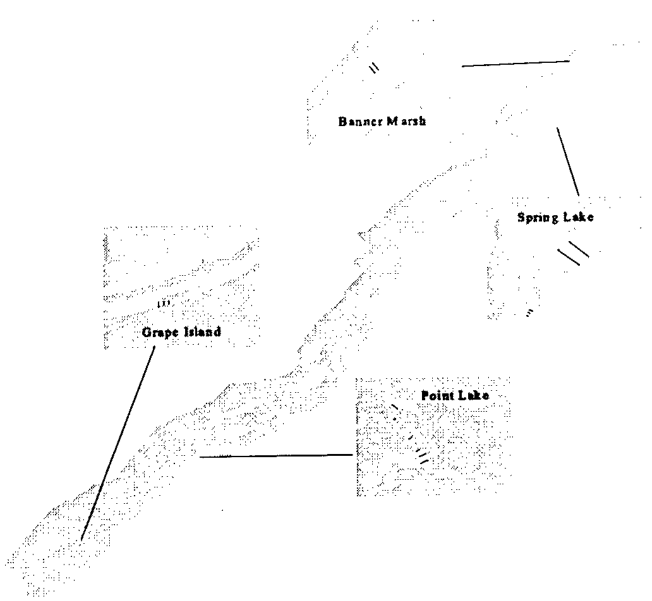

Figure 6. Location and arrangement of transects in La Grange Pool (Illinois River) in 1998.

Methods

Transect Sampling

The transect sampling scheme was designed to investigate aquatic vegetation along imaginary straight lines that traverse a backwater (or location), typically from shoreline to shoreline. These lines are traditionally called transects. The arrangement of transects in each backwater was determined in the first year (mostly during 1991) the backwater was chosen for monitoring (Figures 2–6). The transects are usually parallel lines of equal distance apart (50–200 m). During sampling, a field crew drives a boat along each transect and stops at regular distances (Appendix A). Each stop is called a sampling site.

Aquatic vegetation was sampled once each in spring and summer. Spring sampling is usually between May 15 and June 15 and summer sampling is usually between July 15 and August 31 (Rogers and Owens 1995). Since 1996, water temperature was utilized to determine the onset of spring sampling in addition to the rule of calendar dates. Accordingly, spring sampling begins when water temperature in the backwaters reaches 18° C, the temperature at which most submersed aquatic species have begun to grow and elongate (Barko and Smart 1981; Madsen and Adams 1988; Flint and Madsen 1995). Sampling should be initiated by May 22 regardless of temperature so it can be completed in time. In 1998, spring sampling was between May 18 and June 23 and summer sampling was between July 21 and September 3 for all field stations (Appendix A).

The method of sampling aquatic vegetation at each site was modified from a technique used by Jessen and Lound (1962). The sampling area was a 2-m circle immediately in front of the bow of the boat. It was divided into thirds from which plants were collected using a long-handled thatching rake. The rake was lowered to the bottom, twisted 180 degrees to snag vegetation, and then retrieved. The thatching rake had a 38-cm (15-inch) head with 20, 12.7-cm-long (5-inch) teeth. The area covered by the rake head during the twisting is approximately 0.1 m^2. Submersed plant species collected on the rake were identified and recorded. After all three segments of the circle were sampled, each species was assigned a rating of 1, 2, or 3 corresponding to the number of times the species was retrieved in the three rake samples. A rating of 4 was assigned if a species completely covered the rake teeth on all three twists. Beginning in 1997, a rating of "9" was given to species observed in the sampling area but not retrieved in any of the three rake samples. In previous years, such species were not recorded as legitimate entries. Water depth at each site was measured to the nearest decimeter using the handle of the rake, which is scaled and marked. Residual sediment retrieved on the rake during vegetation sampling was classified into one of three categories based on visual and tactile characteristics. These categories include silt and/or clay, mostly silt with some sand, and mostly sand with some silt. Sediment types were recorded for individual transects rather than for individual sites.

If a rooted floating-leaved species was present, it was assigned a rating of 1 to 4 based on the

amount of vegetative cover visible in the entire 2 m sampling area (1 = 1–25% cover, 2 = 26–50% cover, 3 = 51–75% cover, and 4 = 76–100% cover). A nonrooted floating species (e.g., Lemnaceae) was recorded only if it exceeded 5% of the surface area, but was excluded from analysis.

Fassett (1957), Voss (1972, 1985) and Gleason and Cronquist (1991) were the primary keys used for plant identification. Scientific nomenclature and common names are based on those found in the U.S. Department of Agriculture PLANTS Database on the Internet (http://plants.usda.gov/plants/). Leafy pondweed (*Potamogeton foliosus*) and small pondweed (*P. pusillus*) were usually not identified to species during field sampling and were recorded in a code "NLPW" for "small or leafy pondweeds." In some instances they were identified to species, then the record with the higher rating at the site was kept and renamed NLPW in analysis. Eurasian watermilfoil (*Myriophyllum spicatum*) includes specimens that were identified to species as well as specimens recorded as *Myriophyllum* spp.

Since 1991, voucher specimens have been collected and stored at each field station. Rare species and unusual specimens were sent to outside experts for verification.

Unusual Situation

Because of human error, species rating in Pool 13 in 1998 was assigned on a scale of 3 rather than 4. A submersed aquatic species was assigned a rating of 1, 2, or 3 corresponding to the number of times the species was retrieved in the three rake samples. Rating of a rooted floating-leaved species was assigned as follows: 1 = 1–33% cover, 2 = 34–67% cover, and 3 = 68–100% cover.

Data Summary

The frequency of a species is the number of sites in which the species were found, divided by the total number of the sites surveyed in the backwater, multiplied by 100 (percent). The frequencies of submersed or floating-leaved vegetation were similarly calculated. The frequency of a species in any year was the higher value of the spring and summer frequencies. This treatment was based on considerations of the seasonality and the opportunistic nature of aquatic plant species in a river environment. The frequency data of 1998 were compared with frequency data of 1997 to determine whether an increase or decrease was statistically significant. Based on the assumption that the frequency of species in a backwater in any year is an independent variable that has a binomial distribution, a 95% confidence interval for the true difference between 1997 and 1998 was computed according to the following formula (Walpole and Myers 1978):

$$(p_1-p_2)-1.96\sqrt{\frac{p_1q_1}{n_1}+\frac{p_2q_2}{n_2}}<(P_1-P_2)<(p_1-p_2)+1.96\sqrt{\frac{p_1q_1}{n_1}+\frac{p_2q_2}{n_2}}$$

where p_1 and p_2 are the frequencies of presence of a species in 1997 and 1998, respectively; n_1 and n_2 are the total number of sites sampled of 1997 and 1998, respectively; P_1 and P_2 are the unknown "true" frequencies of presence of the species in 1997 and 1998, respectively; and $q_1 = 100 - p_1$ and $q_2 = 100 - p_2$. If the interval contains the value zero, then the frequency of 1998 is concluded to be statistically the same as the frequency of 1997. Otherwise, we noted whether the 1998 frequency was an increase or decrease from the previous year. Also, we noted when a species was found for the first time in a backwater, when a species was present the previous year and not found in 1998, and when a species reappeared after a disappearance of one or more years. The frequency of a species is compared with available data for the period 1991–97 and noted whether it is the high or low for that period. Details are given for the individual pools in Results and Discussion following.

Results and Discussion

Pool 4

Based on data from nine backwaters, we concluded that the status and trend of aquatic vegetation in Pool 4 in 1998 differ between the upper pool (above Lake Pepin) and lower pool

(below Lake Pepin). Aquatic vegetation in the lower pool had another moderately good growing season in 1998 (Figure 7, Table 1). Compared with 1997, none of the five backwaters in the lower pool had decreased frequency of vegetated sites, whereas the frequency of submersed or rooted floating-leaved vegetation increased in Big Lake and the frequency of submersed vegetation sites increased in Robinson Lake. The 1998 growing season in the lower pool seemed to be an extension of a rebounding momentum that began in 1997. In contrast, aquatic vegetation in the upper pool had a poor growing season (Figure 7; Table 1). Compared with 1997, the frequency of submersed or rooted floating-leaved vegetation decreased in three—Goose, Dead Slough, and Mud Lakes—of the four backwaters surveyed. The 1998 growing season in the upper pool seemed to be an extension of a decline that began in 1992. Upper Pool 4 was species poor, typical since 1991; sago pondweed (*Potamogeton pectinatus*) was the only species found in 1998. Lower Pool 4, on the other hand, was species rich with 12 species of submersed and 2 of rooted floating-leaved plants found in 1998.

Wild celery (*Vallisneria americana*) was the most frequently encountered (MFE) species in Lower (19%) and Upper Peterson Lakes (27%) and Big Lake (14%). Curly pondweed (*Potamogeton crispus*) increased significantly in 1998 in Lower and Upper Peterson Lake. Eurasian watermilfoil was once again the MFE submersed species in Rice Lake–Big Lake Bay (22%), although it showed a nonsignificant decline in frequency from 1997. American lotus (*Nelumbo lutea*) remained the MFE aquatic species in these backwaters (31%). Water stargrass (*Heteranthera dubia*), the MFE species in Robinson Lake (43%), exhibited a significant increase in four of five lower pool backwater areas, including Upper Peterson Lake, Big Lake, Rice Lake–Big Lake Bay and Robinson Lake in 1998. Curly pondweed, flatstem pondweed (*P. zosteriformis*), Eurasian watermilfoil, Canadian waterweed (*Elodea canadensis*), and wild celery also showed significant increases in 1998 in Robinson Lake, the only backwater area in Pool 4 that had aquatic vegetation frequencies greater than 60%. Wild celery and water stargrass were both sampled at a high for the period 1991–98 along the

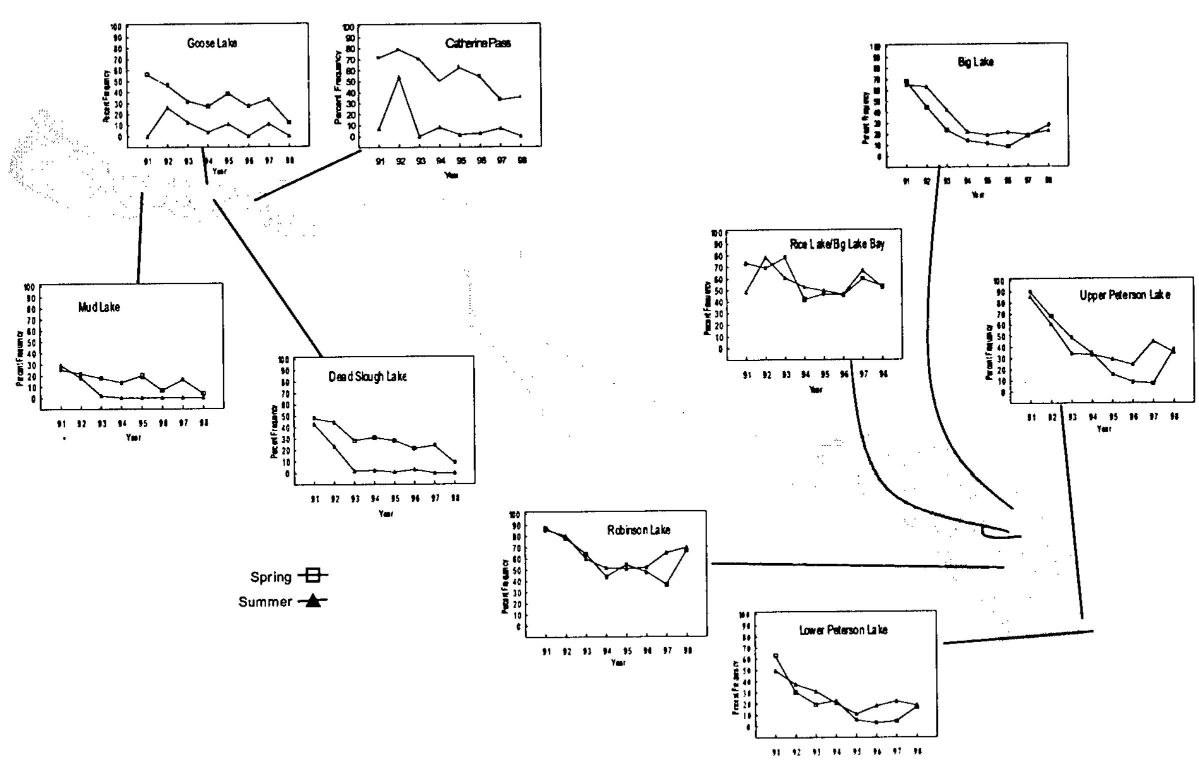

Figure 7. Frequency of aquatic vegetation in nine backwaters in Pool 4 (Upper Mississippi River), 1991-1998.

Table 1. Percent frequency of aquatic plant species by backwater or location in Pool 4, Upper Mississippi River, during the spring (Sp, May 26–June 17) and summer (Su, August 12–September 2) sampling periods, 1998.

Species		Lower Peterson Lake Sp	Lower Peterson Lake Su	Upper Peterson Lake Sp	Upper Peterson Lake Su	Big Lake Sp	Big Lake Su	Rice Lake–Big Lake Bay Sp	Rice Lake–Big Lake Bay Su	Robinson Lake Sp	Robinson Lake Su	Catherine Pass[a] Sp	Catherine Pass[a] Su	Goose Lake[a] Sp	Goose Lake[a] Su	Dead Slough Lake[a] Sp	Dead Slough Lake[a] Su	Mud Lake[a] Sp	Mud Lake[a] Su
	n	130	86	69	97	157	148	71	67	203	218	71	74	25	24	134	133	57	54
Submersed species																			
coontail	(*Ceratophyllum demersum*)	1.5	1.2	8.7	9.3	-	-[b]	5.6	16.4	18.7	24.4	-	-	-	-	-	-	-	-[b]
pondweed, horned	(*Zannichellia palustris*)	-	-	4.3[c]	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-
pondweed, curly	(*Potamogeton crispus*)	8.5[d]	-	17.4[d]	3.1	5.7	0.7	2.8	3.0[e]	27.6[d]	1.4	-	-	-	-	-	-	-	-
pondweed, flatstem	(*P. zosteriformis*)	-	-	-	-	-	-	-	1.5[f]	1.5	5.2[d]	-	-	-	-	-	-	-	-
pondweed, longleaf	(*P. nodosus*)	-	-	-	-	-	0.7	-	3.0[e]	0.5	0.5	-	-	-	-	-	-	-	-
pondweed, sago	(*P. pectinatus*)	6.2	1.2	18.8	5.2	2.5	-	-	3.0[e]	21.2	9.9	35.2	-	12.0[e,g]	-	9.0[e,g]	-	3.5[e,g]	-
pondweeds, small or leafy	(*P. foliosus, P. pusillus*)	-	-	4.3	2.1	0.6[f]	-	2.8	6.0	3.9	1.9	-	-	-	-	-	-	-	-
water stargrass	(*Heteranthera dubia*)	-	3.5	-	17.5[d]	3.8	7.2[d]	-	10.4[c,d,f]	15.8	42.7[c,d]	-	-	-	-	-	-	-	-
watermilfoil, Eurasian	(*M. spicatum*)	1.5	1.2	7.2	7.2	2.5	1.3	16.9	22.4	9.4	15.5[d]	-	-	-	-	-	-	-	-
watermilfoil, northern	(*M. sibiricum*)	-	-	-	-	-	-	-	-[b]	-	-[b,g]	-	-	-	-	-	-	-	-
waternymph, nodding	(*Najas flexilis*)	-	-	-	-[b]	-	0.7[f]	-	1.5[f]	-	0.5	-	-	-	-	-	-	-	-
waterweed, Canadian	(*Elodea canadensis*)	2.3	2.3	10.1	9.3	1.3	-	4.2	9.0	25.6[d]	20.7	-	-	-	-	-	-	-	-
wild celery	(*Vallisneria americana*)	0.8	18.6	4.3	26.8	9.6	13.7	2.8	14.9[e]	25.1	42.3[c,d]	-	-	-	-	-	-	-	-
Rooted floating-leaved species																			
lotus, American	(*Nelumbo lutea*)	-	-	-	-	11.5	13.1[c]	31.0	17.9	1.5[e]	0.9	-	-	-	-	-	-	-	-
waterlily, American white	(*Nymphaea odorata*)	0.8	-	-	2.1	1.9[g]	1.3	23.9	16.4	18.7	20.2	-	-	-	-	-	-	-	-
Algae																			
filamentous algae	(Chlorophycaea)	-	-	1.4[h]	6.2[d]	-	0.7[h]	4.2[d,f]	-	5.9[c,d,f]	2.3	-	-	-	-	-	-	-	-
Frequency of submersed vegetated sites		16.9	18.6	37.7	35.1	18.5	17.0	25.4	47.8	63.1	65.3[d]	35.2	-	12.0[e,g]	-	9.0[e,g]	-	3.5[e,g]	-
Frequency of rooted floating-leaved vegetated sites		0.8	-	-	2.1	12.7	14.4	40.8	31.3	19.7	20.2	-	-	-	-	-	-	-	-
Frequency of submersed and/or rooted floating-leaved sites		16.9	18.6	37.7	35.1	27.4[d]	22.9	53.5	52.2	67.0	69.5	35.2	-	12.0[e,g]	-	9.0[e,g]	-	3.5[e,g]	-

[a]Located upstream of Lake Pepin.
[b]Disappeared between 1997 and 1998.
[c]Highest record of 1991–1998.
[d]Significant increase from 1997.
[e]Lowest record of 1991–1998.
[f]Reappeared after absence in 1997.
[g]Significant decrease from 1997.
[h]First record.

transects of Robinson Lake and Rice Lake–Big Lake Bay in 1998.

Sago pondweed reached a low in frequency for the period 1991–98 in three of four upper pool backwaters. Only one of four upper pool backwaters had aquatic vegetation frequencies greater than 15% during the spring sampling period. No aquatic plants were sampled in these backwaters during the summer sampling period.

Overall, 12 submersed and 2 rooted floating-leaved aquatic species were sampled in the 9 backwater areas of Pool 4 in 1998. Northern watermilfoil (*Myriophyllum sibiricum*), a native milfoil found in two backwaters in 1997, disappeared in 1998. The only species common to all nine backwaters was sago pondweed. Horned pondweed (*Zannichellia palustris*) was unique to spring sampling and nodding waternymph (*Najas flexilis*) to summer sampling. Robinson Lake once again had the highest species richness with all 14 species present.

Pool 8

According to data from eight backwaters, Pool 8 aquatic vegetation grew very well in 1998 (Figure 8, Table 2). The frequency of vegetated sites (submersed or rooted floating-leaved species) was greater than 70% in each of the eight backwaters. Horseshoe, Shady Maple, Lawrence Lake, and the Goose Island backwater had the highest frequencies since 1991. Shady Maple and Lawrence Lake increased from 1997, whereas Target Lake decreased. The frequency of vegetated sites was 100% at Blue Lake and the Goose Island backwater. Submersed vegetation increased in four backwaters and decreased in one, whereas rooted floating-leaved vegetation remained constant in all eight backwaters. A multiple number of species had increased or highest frequencies in all 8 backwaters, especially in Lawrence Lake where 13 species had increased or highest frequencies. The 1998 season seemed to be a continuation of a trend of increased growth begun in previous years, and the status of aquatic vegetation in 1998 was at or near the best since 1991 (Figure 8).

Seventeen species of aquatic plants (13 submersed, 3 floating-leaved and 1 macroalgae) were found in transect sampling in 1998. Coontail (*Ceratophyllum demersum*), curly, sago, and small or leafy pondweeds, Canadian waterweed, and American white waterlily (*Nymphaea odorata*) were found in all eight backwaters. The macroalgae chara (*Chara* spp.) was found in Lawrence Lake for the first time during LTRMP sampling in 1998. Lawrence Lake had the highest species richness (16 species).

Coontail (96%) and Canadian waterweed (68%) were the MFE species in the Stoddard backwater, whereas American white waterlily (91%) and small or leafy pondweeds (88%) were most common in Blue Lake. Coontail decreased from 91% (1997) to 82% (1998) in Blue Lake, dropping it from the first to the third MFE species. Both backwaters are isolated from the main channel. Sago and curly pondweeds and American lotus were the dominant species in the Horseshoe (46%, 24%, and 23%, respectively) and Boomerang (53%, 35%, and 36%, respectively) Island sites, both of which are in the impounded area of Pool 8 and are open to southern winds. Canadian waterweed (56%), coontail (53%), and water stargrass (53%) were the MFE species in Shady Maple. In Lawrence Lake (88%), Goose Island (98%), and Target Lake (55%), coontail was the MFE species. These four backwaters are connected to the main channel. Water stargrass reappeared in three backwaters and increased to highs in all five backwaters in which it was present.

Pool 13

Pool 13 aquatic vegetation, according to data from seven backwaters, had an excellent growing season in 1998 (Figure 9, Table 3). The frequencies of vegetated sites (submersed or rooted floating-leaved aquatic vegetation) and the number of species found either increased from the previous year or remained high in 1998. The frequencies of vegetated sites reached their highest since 1991 in Johnson Creek Levee, Potter's Marsh, Pomme de Terre, and Savanna Bay; increased from the

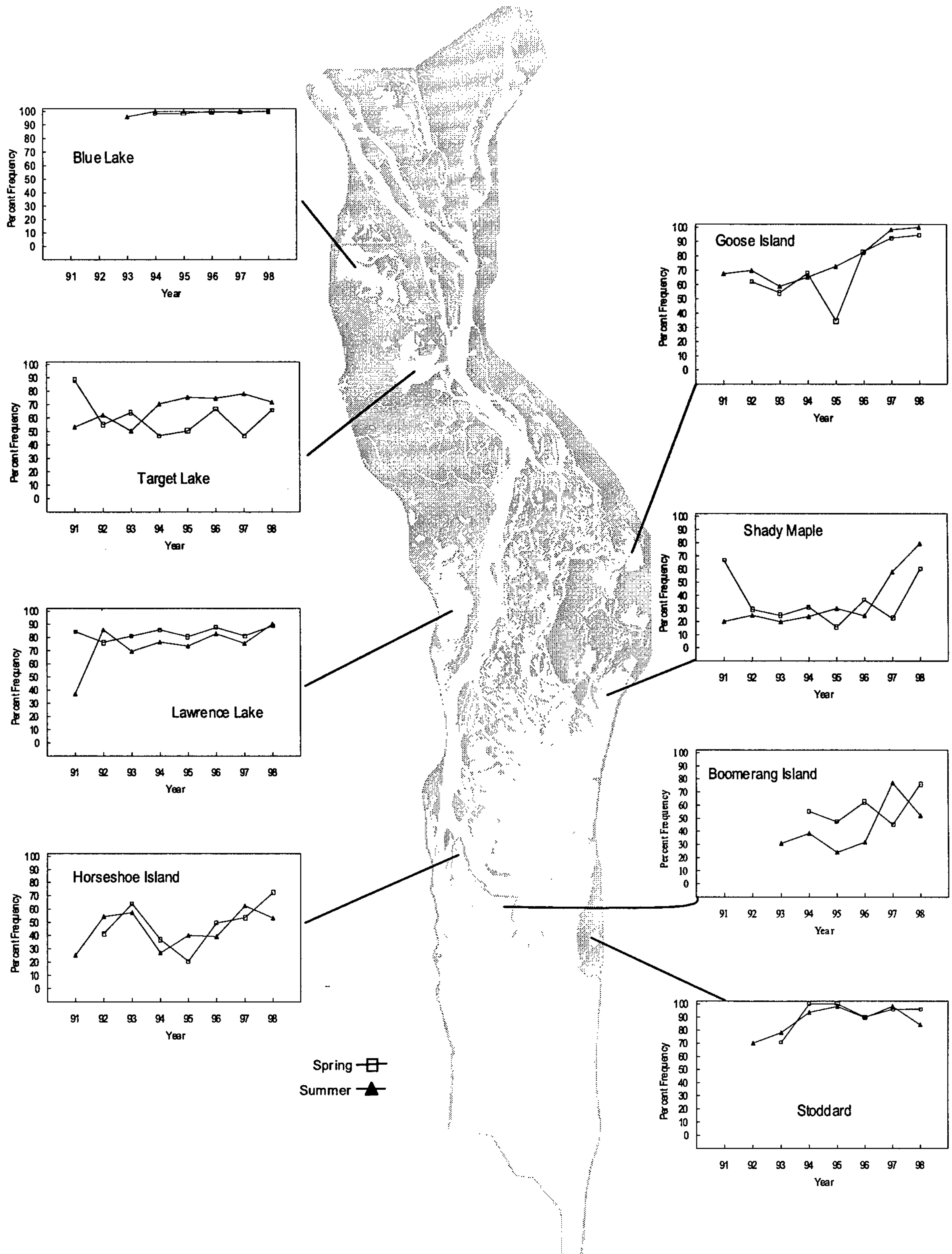

Figure 8. Frequency of aquatic vegetation in eight backwaters in Pool 8 (Upper Mississippi River), 1991–1998.

Table 2. Percent frequency of aquatic plant species by backwater or location in Pool 8, Upper Mississippi River, during spring (Sp, May 19–June 11) and summer (Su, July 21–August 25) sampling periods, 1998.

Species		Stoddard		Boomerang Island		Horseshoe Island		Shady Maple		Lawrence Lake		Goose Island		Target Lake		Blue Lake	
		Sp	Su	Sp	Su	Sp	Su	Sp	Su	Sp	Su	Sp	Su	Sp	Su	Sp	Su
	n	50	50	104	104	83	81	102	106	434	441	111	115	290	292	134	132
Submersed species																	
bladderwort, common	(*Utricularia macrorhiza*)	-	-	-	-	-	-	-	-	10.0	13.4[a,b]	-	-	0.3	3.8[a]	11.2	35.6[a,b]
buttercup, longbeak	(*Ranunculus longirostris*)	-	-	-	-	-	-	-	-	-	-[c]	-	-	-	-	-	-
coontail	(*Ceratophyllum demersum*)	96.0[b]	84.0	1.0	-	6.0	22.2[a,b]	36.3	52.8[a,b]	75.8	87.8[a,b]	87.4	98.3[a,b]	25.5	54.5[a]	82.1[d]	81.1
pondweed, horned	(*Zannichellia palustris*)	-	-	4.8[a,b]	-	-	1.2[e]	-	-	-	-	-	-	-	-	-	-[c]
pondweed, curly	(*Potamogeton crispus*)	56.0[b]	6.0	34.6[a,b]	-	24.1[a,b]	4.9	6.9	0.9	51.0[a]	21.8	27.0[b]	13.9	7.6[b]	5.5	26.9	3.0
pondweed, flatstem	(*P. zosteriformis*)	-	-[c]	-	-	-	-	8.8	34.0[a,b]	7.7	9.3	53.2	64.3[a,b]	-	-	-	0.8[e]
pondweed, longleaf	(*P. nodosus*)	-	-	-	-[c]	-	-	-	0.9	2.1[b]	0.9	1.8	0.9	0.7	1.4	-	-
pondweed, sago	(*P. pectinatus*)	22.0[d]	10.0	52.9[b]	1.9	45.8[b]	14.8	20.6	7.5	33.1	34.2[a]	11.7	6.1	41.0[d]	33.2	6.0	15.9
pondweeds, small or leafy	(*P. foliosus, P. pusillus*)	6.0	-	1.0	-	8.4	6.2	6.9	7.5[d]	32.4[a,b]	13.8	21.6[b]	13.9	19.7	21.6[b]	88.1[a,b]	29.5
water stargrass	(*Heteranthera dubia*)	-	-	1.0	27.9[a,b]	-	13.6[a,b,c]	7.8	52.8[a,b]	2.6	10.2[a,b]	6.3[a,b,c]	4.3	0.7[e]	3.8[a,b]	-	-
watermilfoil, Eurasian	(*Myriophyllum spicatum*)	-	-	-	1.0	7.2	17.3	7.8	27.4[a,b]	38.5	42.6[a]	22.5[d]	20.0	0.7	3.1	-	-
waternymph, nodding	(*Najas flexilis*)	-	-	-	-	-	12.3[a,b]	-	-	3.5	13.6[a,b]	-	1.7	-	3.8[a]	8.2	17.4
waterweed, Canadian	(*Elodea canadensis*)	68.0	62.0	1.9	4.8	1.2	12.3[b]	27.5	55.7[a,b]	5.8	15.2[a,b]	51.4	75.7[a,b]	1.4	10.3[a]	-	3.8
wild celery	(*Vallisneria americana*)	-	-	-	3.8[b]	-	4.9[b]	-	6.6[a,b]	0.2	0.5[b]	-	-	-	-	-	-
Rooted floating-leaved species																	
American lotus	(*Nelumbo lutea*)	-	-	28.8	35.6	22.9	17.3	10.8	13.2[b]	14.7	16.3[b]	18.9	13.9	22.4	39.4[b]	4.5[b]	4.5
pondlily, yellow	(*Nuphar variegata*)	2.0[e]	-	-	-	-	-	-	-	12.6	11.6	-	-[c]	-	-	2.2	0.8
waterlily, American white	(*Nymphaea odorata*)	16.0[f]	16.0	1.0[e]	-	2.4	8.6[a]	2.0	1.9	49.4	51.7	36.9	42.6	23.1	28.4[f]	91.0	90.2
Algae																	
chara	(*Chara* spp.)	-	-	-	-	-	-	-	-	-	0.9[a,g]	-	-	-	-	-	-
filamentous algae	(Chlorophycaea)	48.0	-	1.0[d]	1.0	1.2	4.9	-	5.7[b]	67.6[a,b]	51.0	38.7	42.6[a]	3.8[a]	1.7	-	-[c]
Frequency of submersed vegetated sites		96.0	84.0	73.1[b]	31.7	66.3[a,b]	44.4	56.9	76.4[a,b]	88.8	89.8[a,b]	91.9	100.0[a,b]	60.0	67.1[d]	96.3	85.6
Frequency of rooted floating-leaved vegetated sites		18.0[f]	6.0	29.8	35.6	25.3	25.9	12.7	14.2[b]	58.5	58.7	52.3	53.9	41.4	49.0	91.8	93.9[b]
Frequency of submersed and/or rooted floating-leaved sites		96.0	84.0	76.0	51.9	72.3[b]	53.1	59.8	79.2[a,b]	88.8	90.2[a,b]	94.6	100.0[b]	65.9	71.6[d]	100.0	100.0

[a]Significant increase from 1997.
[b]Highest record of 1991–1998.
[c]Disappeared between 1997 and 1998.
[d]Significant decrease from 1997.
[e]Reappeared after absence in 1997.
[f]Lowest record of 1991–1998.
[g]First record.

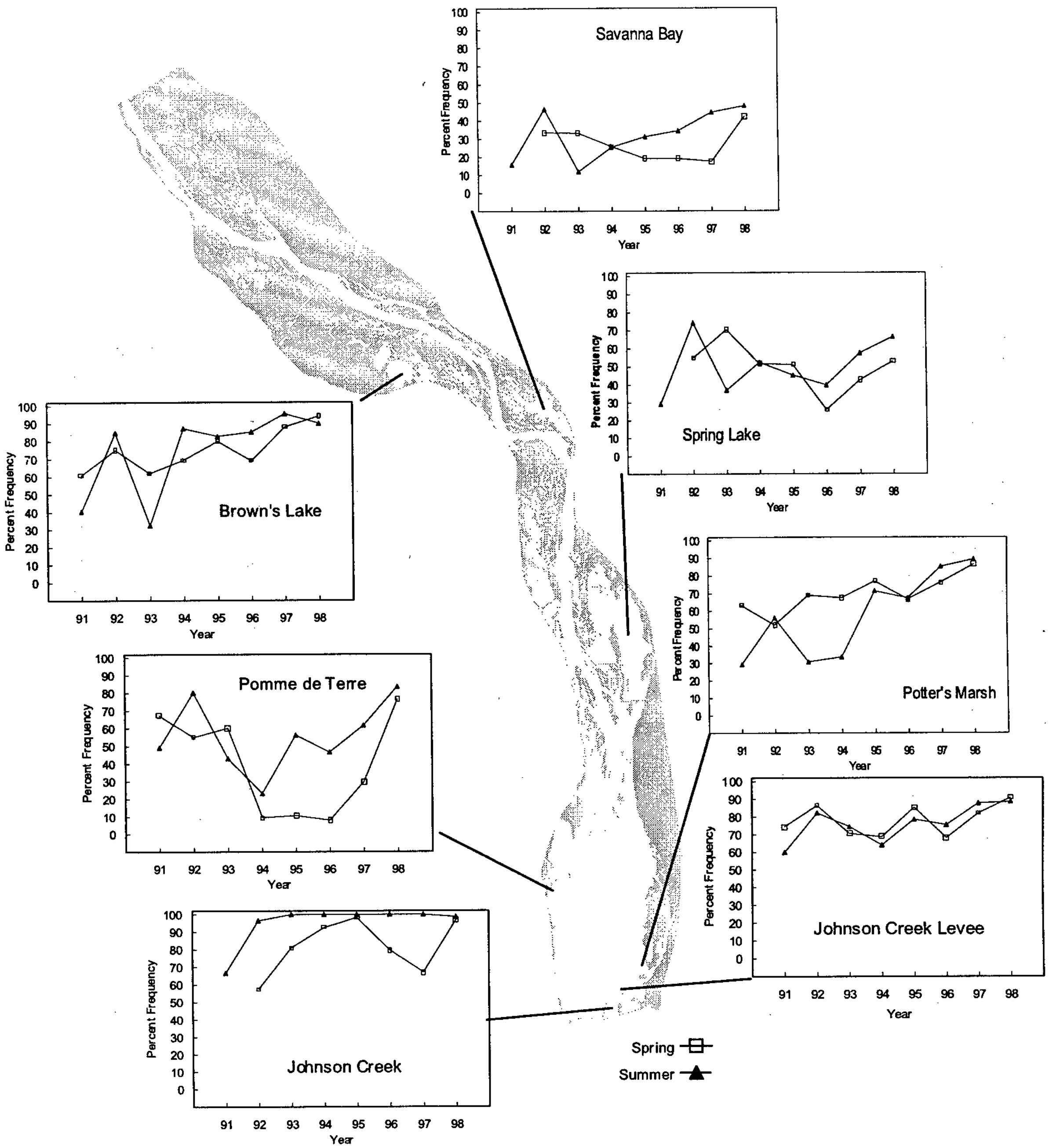

Figure 9. Frequency of aquatic vegetation in seven backwaters in Pool 13 (Upper Mississippi River), 1991–1998.

previous year in Pomme de Terre and Spring Lake; and remained statistically the same as in 1997 in Johnson Creek and Brown's Lake. Eleven species and one macroalgae reached highs in one or more backwaters. Except for Savanna Bay and Brown's Lake, each of the other five backwaters had at least four taxa that reached highs in 1998. The 1998 growing season appeared to be a continuation of a trend of increase begun in previous years, and the condition of aquatic vegetation in 1998 was at or near the best since 1991 (Figure 9).

The dominant species varied among the seven backwaters. In Johnson Creek, the southernmost study area in Pool 13, American lotus was the MFE species (91%), followed closely by water stargrass and wild celery both at 88%. Wild celery was the MFE species on Johnson Creek Levee at 85% followed by water stargrass at 76%. The reverse was apparent on Potter's Marsh where water stargrass was present at 80% of the sites and wild celery 73% of the sites. On the basis of visual inspection during the sampling, we estimated that

Table 3. Percent frequency of aquatic plant species by backwater or location in Pool 13, Upper Mississippi River, during spring (Sp, May 21–June 23) and summer (Su; August 3–September 3) sampling periods, 1998.

Species		Johnson Creek		Johnson Creek Levee		Potter's Marsh		Pomme de Terre		Spring Lake		Savanna Bay		Brown's Lake	
		Sp	Su	Sp	Su	Sp	Su	Sp	Su	Sp	Su	Sp	Su	Sp	Su
	n	66	67	108	114	110	132	68	85	153	179	144	143	432	422
Submersed species															
coontail	(*Ceratophyllum demersum*)	36.4	79.1	20.4	28.1[a]	4.5	16.7[a,b]	38.2	61.2[a]	13.7	35.2[a]	28.5	39.9[a,b]	68.8	84.8[a,b]
pondweed, horned	(*Zannichellia palustris*)	-	-[c,d]	-	-	-	-	-	-	-	-	-	-	0.5[e]	-
pondweed, curly	(*Potamogeton crispus*)	4.5	17.9	6.5[a]	0.9	3.6	-	4.4	2.4	7.2	-	1.4	0.7	14.6[a]	-
pondweed, flatstem	(*P. zosteriformis*)	3.0	-	-	-[c,d]	-	-	-	-	-	-	-	-	-	-
pondweed, longleaf	(*P. nodosus*)	4.5	19.4[b]	9.3	6.1	2.7[b]	1.5	4.4	4.7	7.8	8.4	-	-	3.0	0.7
pondweed, sago	(*P. pectinatus*)	34.8	28.4	42.6	14.0	54.5	9.1	35.3[a]	8.2	34.0[c]	6.7	18.1	7.7	56.5[f]	28.9
pondweeds, small or leafy	(*P. foliosus, P. pusillus*)	-	14.9[a,b]	0.9[c]	-	-	-	-	7.1[a,b,g]	5.9[a,b]	0.6	0.7[c]	-	6.3[a,b]	0.5
water stargrass	(*Heteranthera dubia*)	28.8	88.1[a]	33.3	76.3[b]	25.5	80.3[b]	1.5	70.6[a,b]	13.1	29.1[a,b]	4.9	12.6[a,b]	-	-
watermilfoil, Eurasian	(*Myriophyllum spicatum*)	15.2	22.4	50.0	30.7	51.8[a,b]	47.0	22.1	29.4	11.1	12.8[a,b]	-	0.7[g]	-	-
waternymph, nodding	(*Najas flexilis*)	-	3.0[c]	-	5.3[c]	0.9	4.5	-	4.7[b]	9.2	33.0[a,b]	-	-	-	-
waternymph, southern	(*N. guadalupensis*)	-	29.9[a,b]	5.6	7.0[b]	1.8	1.5	-	7.1[b]	-	-[c,d]	-	-	-	-
waterweed, Canadian	(*Elodea canadensis*)	1.5	17.9	-	13.2	1.8[g]	29.5[a,b]	11.8	45.9[a,b]	4.6	10.1[a,b]	-	0.7[g]	0.2[c]	-
wild celery	(*Vallisneria americana*)	66.7	88.1[b]	81.5	85.1[a,b]	57.3	72.7[a,b]	39.7	49.4[a,b]	0.7	4.5[a,b]	-	-	-	-
Rooted floating-leaved species[a]															
American lotus	(*Nelumbo lutea*)	40.9	91.0[b]	11.1	21.9	2.7	6.1	7.4	10.6[a]	18.3	50.8[a,b]	8.3	21.7[c]	85.6[c]	60.0
waterlily, American white	(*Nymphaea odorata*)	12.1	37.3	5.6	14.9	-	-	8.8	10.6[b]	2.0	3.4	-	-	0.2	0.2
Algae[a]															
chara	(*Chara* spp.)	-	7.5[a,b,g]	0.9	-	-	-	-	-	0.7[e]	-	-	-	-	-
filamentous algae	(Chlorophycaea)	60.6[a]	23.9	36.1	69.3[a,b]	29.1	53.8[c]	13.2	48.2[a,b]	26.1[a,g]	7.8	8.3	17.5[a,g]	55.1[a]	17.3
nitella	(*Nitella* spp.)	-	1.5[c]	-	-	-	-	-	-	-	-	-	-	-	-
Frequency of submersed vegetated sites		93.9	98.5	90.7[b]	88.6	86.4	89.4[b]	75.0	83.5[a,b]	52.3	53.1	38.9	45.5[a,b]	80.1	85.8[a]
Frequency of rooted floating-leaved vegetated sites		50.0	97.0	13.9	21.9	2.7	6.1	16.2	21.2[a]	19.0	50.8[a]	8.3	21.7[c]	85.6[c]	60.0
Frequency of submersed and/or rooted floating-leaved sites		97.0	98.5	90.7[b]	88.6	86.4	89.4[b]	76.5	83.5[a,b]	52.9	66.5[a]	42.4	48.3[b]	94.0	90.0

[a]Significant increase from 1997.
[b]Highest record of 1991–1998.
[c]Significant decrease over 1997.
[d]Disappeared between 1997 and 1998.
[e]First record.
[f]Lowest record of 1991–1998.
[g]Reappeared after absence in 1997.

American lotus would have had higher than recorded frequencies in Potter's Marsh and Johnson Creek Levee if transects in the two backwaters were extended to the shoreline. Because the transects were established in 1991 and their locations remain unchanged, a large portion of the American lotus beds between the shoreline and the starting points of transect were missed in the transect sampling. In Pomme de Terre, the northernmost impounded area sampled, water stargrass was the MFE species (71%), followed by coontail (61%). American lotus was the MFE species in Spring Lake (51%) and Brown's Lake (86%), whereas coontail was a MFE species (40%) in Savanna Bay.

Wild celery and water stargrass reached highs for the period 1991–98 in five backwaters and increased from 1997 in four backwaters. Water stargrass was present in six backwaters whereas wild celery was present in five. Small or leafy pondweeds were found in Johnson Creek Levee and Savanna Bay for the first time and reappeared in Pomme de Terre at its highest frequency for the period 1991–98. Horned pondweed was found in Brown's Lake for the first time but disappeared from Johnson Creek. Flatstem pondweed disappeared from Johnson Creek Levee; and southern waternymph (*Najas guadalupensis*) disappeared from Spring Lake. Eurasian watermilfoil, an invasive exotic species, was found in six of the seven backwaters and reached highest frequencies in Potter's Marsh and Spring Lake for the period 1991–98. It reappeared in Savanna Bay after an absence in 1997, and its frequency in Spring Lake doubled from 1997 to 1998.

Seventeen species (not including filamentous algae) were found in Pool 13 in 1998. Chara, nitella (*Nitella* spp.), small or leafy pondweeds, Canadian waterweed, Eurasian watermilfoil, and horned pondweed reappeared after an absence in 1997 or made a first appearance in one or more locations. Flatstem and horned pondweeds were unique to the spring sampling episode and nitella was unique to summer. Coontail, curly and sago pondweed, Canadian waterweed, and American lotus were found in all seven backwaters.

According to notes of casual observations, some Eurasian watermilfoil leaflets on the Johnson Creek Levee transects appeared to have been eaten this year, possibly by insect or fish activity. A species of boring worm was observed in large numbers on American lotus in Brown's and Spring Lakes for the last several years. Large numbers of a katydid were observed on the American lotus in Spring Lake this year. Some of the leaves were partially striped.

Pool 26

In general, aquatic vegetation has been rare in contiguous backwater areas in Pool 26 in recent years, especially since a devastating flood in 1993, and based on data from four backwaters, we conclude that the status of aquatic vegetation remained unchanged in 1998. Aquatic vegetation was found in all four backwaters surveyed in 1998, three of the four had no aquatic vegetation in 1997 (Figure 10, Table 4). Stump Lake had one of the highest frequencies of aquatic vegetation since 1991, whereas the other three backwaters remained virtually nonvegetated. Sago pondweed was the only species found in Calhoun Point (1%) and Swan Lake (3%). Coontail (3%) and wingleaf primerosewillow (*Ludwigia decurrens*; 7%) were the only species found in Fuller Lake. Stump Lake is an isolated backwater managed as a moist soil unit. The lake is separated from the main channel of the Illinois River by a low, constructed levee system and a rather wide riparian forest buffer. Sago pondweed was the MFE submersed aquatic plant in Stump Lake during 1998 (92%) and exhibited a significant increase in frequency from 1997. Coontail and longleaf pondweed (*Potamogeton nodosus*) were the next most abundant (40%). These species also exhibited significant increases in frequency over their 1997 status. American lotus exhibited a significant increase in frequency between 1997 and 1998 levels. American lotus is most dominant in the lower unit of Stump Lake. Wingleaf primerosewillow reappeared in 1998 along transects in Stump Lake following an absence in 1997 and was most often found growing as thick mats along the margins of the lake.

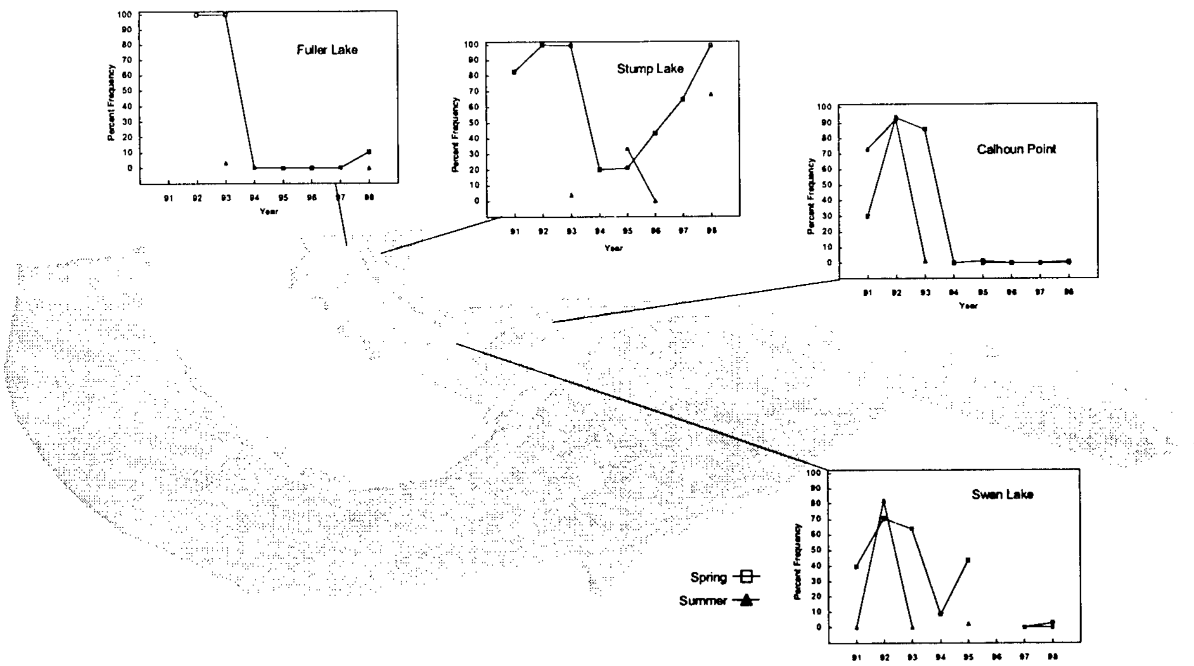

Figure 10. Frequency of aquatic vegetation in four backwaters in Pool 26 (Upper Mississippi and Illinois Rivers), 1991–1998.

Table 4. Percent frequency of aquatic plant species by backwater or location in Pool 26, Upper Mississippi and Illinois Rivers, during spring (Sp; May 18–June 3) and summer (Su; August 4–August 11) sampling periods, 1998.

		Calhoun Point		Swan Lake		Stump Lake		Fuller Lake	
		Sp	Su	Sp	Su	Sp	Su	Sp	Su
Species	***n***	150	157	267	292	169	175	29	29
Submersed species									
coontail	(*Ceratophyllum demersum*)	-	-	-	-	39.6[a]	32.8	3.4[b]	-
pondweed, longleaf	(*Potamogeton nodosus*)	-	-	-	-	36.1	39.7[a,c]	-	-
pondweed, sago	(*P. pectinatus*)	0.7[b]	-	2.6[a,b]	-	92.3[a,c]	25.9	-	-
pondweeds, small or leafy	(*P. foliosus, P. pusillus*)	-	-	-	-	0.6	3.4[a,b]	-	-
water stargrass	(*Heteranthera dubia*)	-	-	-	-	-	0.6[b]	-	-
waterweed, Canadian	(*Elodea canadensis*)	-	-	-	-	0.6[d]	0.6	-	-
Rooted floating-leaved species									
American lotus	(*Nelumbo lutea*)	-	-	-	-	33.1[a]	27.6	-	-
pondlily, yellow	(*Nuphar variegata*)	-	-	-	-	-	-[c]	-	-
primrosewillow, wingleaf	(*Ludwigia decurrens*)	-	-	-	-	5.3[a,b]	2.9	6.9[b]	-
Algae									
filamentous algae	(Chlorophycaea)	-	-	-	-	-	1.7[a,b]	-	-
Frequency of submersed sites		0.7[b]	-	2.6[a,b]	-	98.8[a]	58.0	3.4[b]	-
Frequency of rooted floating-leaved sites		-	-	-	-	35.5[a]	29.3	6.9[b]	-
Frequency of submersed or rooted floating-leaved sites		0.7[b]	-	2.6[a,b]	-	99.4[a]	67.8	10.3[a,b]	-

[a]Significant increase from 1997. [c]Highest record of 1991–1998. [c]Disappeared between 1997 and 1998.
[b]Reappeared after absence in 1997. [d]Significant decrease from 1997.

Frequency of submersed aquatic vegetation among transect sites in Pool 26 backwaters continued to exhibit two distinct patterns related to the 1993 flood. Before 1993, all four backwaters sampled using transect methods contained substantial amounts of submersed aquatic vegetation. Immediately following the 1993 flood, transect surveys indicated the plant communities were nearly eliminated. One pattern evident during the years following the flood can be described as a "recovery." The aquatic plant community in Stump Lake today is very similar to its pre-flood status. This recovery took 5 years. The second pattern can be described as a "crash without recovery." Fuller Lake, Calhoun Point, and Swan Lake continue to support little to no submersed aquatic vegetation.

The environmental conditions favoring or preventing plant community recovery within each of the four backwater lakes sampled along Pool 26 have not been identified. However, observations indicate that Stump Lake may have physical conditions that have favored plant reestablishment following the 1993 flood. For example, its location is farther away from the main river channel than the other backwaters sampled. Between the lake and river are floodplain forests that may act to slow down floodwaters and allow sediments to drop out of suspension before they reach Stump Lake. This improved water clarity would encourage reestablishment of submersed aquatic vegetation. As plants slowly became established, they too would tend to improve water clarity. Conversely, the backwaters that do not support submersed aquatic vegetation are much closer to the main river channel and the water is often more turbid throughout the growing season.

La Grange Pool

Aquatic vegetation has been rare in contiguous backwater areas in La Grange Pool in recent years, especially since a devastating flood in 1993, and based on data from four backwaters, the status of aquatic vegetation remained unchanged in 1998. Aquatic vegetation was found in three of the four backwaters surveyed in 1998; one of the three had no aquatic vegetation in 1997 (Figure 11, Table 5). Grape Island is a side channel border where sago pondweed was found in 1991–94 but has not had aquatic vegetation present during the sampling windows since 1996. However, sago and horned pondweeds were observed in Grape Island during 1995–98 after the summer sampling window closed, often during late September and early October. Unstable water levels within La Grange Pool seemed to have been a factor in this late season growth with the more stable water conditions allowing the plants to establish late in the growing season. Although aquatic vegetation was found during the transect sampling in Banner Marsh and Spring Lake, a stratified random sampling conducted between June 15 and July 15 revealed no submersed aquatic vegetation at any of the 550 sites within La Grange Pool.

Point Lake is a semi-isolated backwater where several aquatic plant species have been found since 1992 including coontail, sago pondweed, and western waterweed (*Elodea nuttali*). Following the flood of 1993, aquatic vegetation within Point Lake has steadily declined until disappearing completely in 1997. Coontail (44%) and wingleaf primrosewillow (32%) reappeared in Point Lake in 1998. Before 1996, coontail was the most abundant species in Point Lake, present at a percent frequency as high as 80% in 1993.

In Spring Lake, Eurasian watermilfoil has been present since the late 1980s. Percent frequencies have been as high as 93% in 1997 and as low as 32% following an out break of aquatic milfoil weevil coupled with an unusually high surface temperature (>108° F) during the summer of 1995 (Wayne Herndon, Iowa Department of Natural Resources fisheries, personal communication). In 1998, percent frequencies of Eurasian watermilfoil, the MFE species, had a significant drop to 63%. Flatstem pondweed, water stargrass, brittle waternymph (*Najas minor*), and Canadian waterweed disappeared along transects in 1998. Although low in abundance (1%), longleaf pondweed made a reappearance after being absent in 1997. Percent frequency of American lotus was recorded at a high of 14% in 1998. Over all percent frequency of sites with submersed aquatic plants

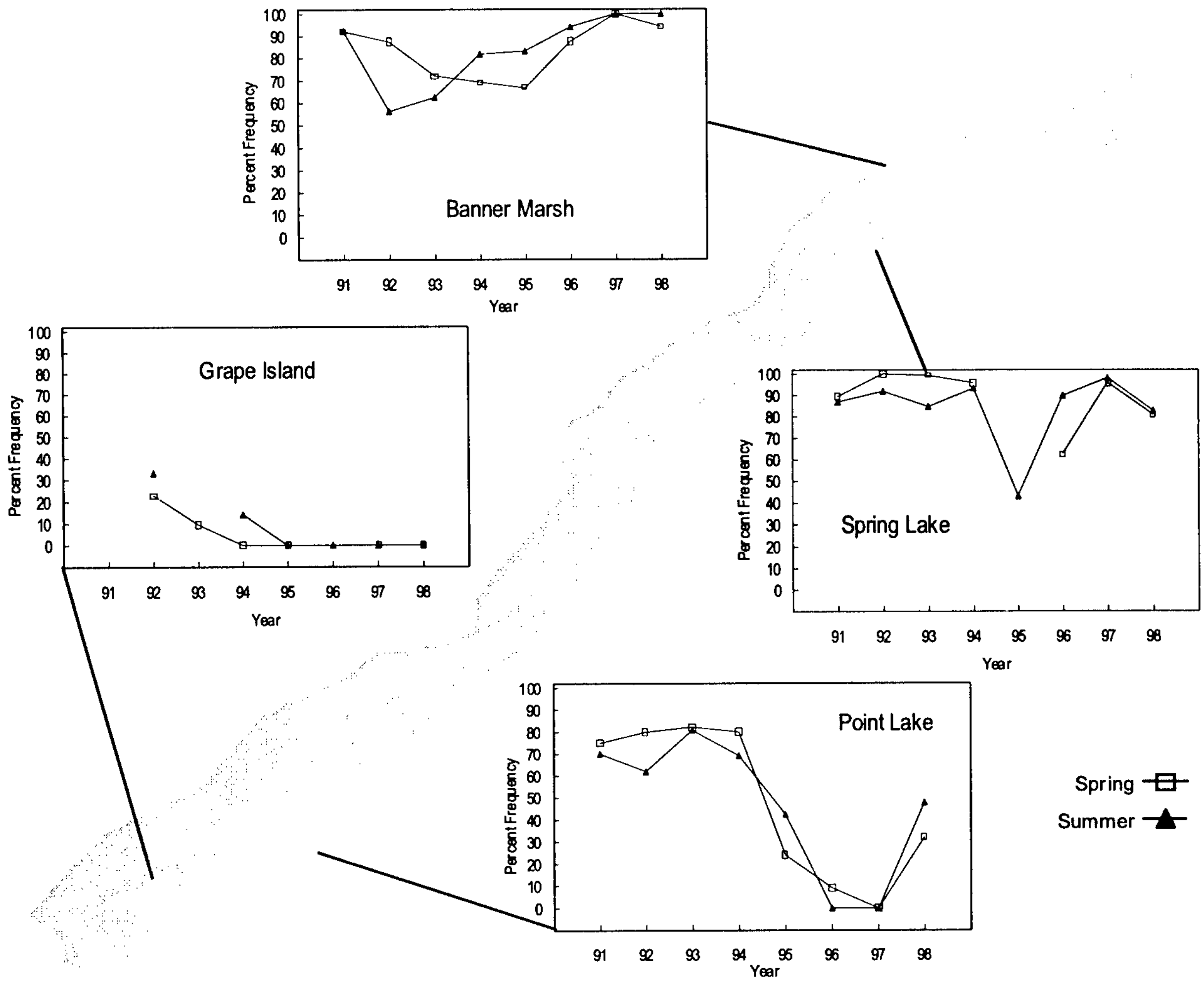

Figure 11. Frequency of aquatic vegetation in four backwaters in La Grange Pool (Illinois River), 1991–1998.

along transects at Spring Lake were down significantly from 99% in 1997 to 83% in 1998.

In Banner Marsh, the frequency of coontail, the MFE species, remained statistically the same as in 1997. Longleaf pondweed increased over the previous year, small or leafy pondweeds reappeared, and water grass and American lotus were first found in 1998. The presence of American lotus in Banner Marsh could be related in part to the connection of Bulrush Pond to an adjacent lotus-filled lake after water elevations in Banner Marsh were raised through the HREP project there.

Acknowledgments

The authors gratefully acknowledge S. Given, J. Hoffmann, S. Kass, K. McKeever, and S. Penniston for their valuable assistance and support. We also thank field station staff at the participating agencies: Minnesota Department of Natural Resources, Lake City; Wisconsin Department of Natural Resources, Onalaska; Iowa Department of Natural Resources, Bellevue; and Illinois Department of Natural Resources, Alton and La Grange.

Table 5. Percent frequency of aquatic plant species by backwater or location in La Grange Pool, Illinois River, during spring (Sp, May 22–June 20) and summer (Su, July 29–August 11) sampling periods, 1998.

		Grape Island		Point Lake		Spring Lake		Banner Marsh	
		Sp	Su	Sp	Su	Sp	Su	Sp	Su
Species	***n***	16	18	25	23	67	86	18	18
Submersed species									
coontail	(*Ceratophyllum demersum*)	-	-	-	43.5[a,b]	4.5	8.1[c]	72.2	83.3
pondweed, horned	(*Zannichellia palustris*)	-	-	-	-	7.5	-	-	-
pondweed, curly	(*Potamogeton crispus*)	-	-	-	-	10.4[d]	-	11.1[b]	5.6
pondweed, flatstem	(*P. zosteriformis*)	-	-	-	-	-	-[d,e]	-	-
pondweed, longleaf	(*P. nodosus*)	-	-	-	-	-	1.2[b]	16.7[b]	33.3[a]
pondweed, sago	(*P. pectinatus*)	-	-	-	-	6.0	5.8	33.3[f]	22.2
pondweeds, small or leafy	(*P. foliosus, P. pusillus*)	-	-	-	-	4.5	-	-	5.6[b]
water stargrass	(*Heteranthera dubia*)	-	-	-	-	-	-[e]	-	11.1[g]
watermilfoil, Eurasian	(*Myriophyllum spicatum*)	-	-	-	-	61.2	62.8[d]	50.0	61.1
waternymph, brittle	(*Najas minor*)	-	-	-	-	-	-[e]	-	-
waternymph, nodding	(*N. flexilis*)	-	-	-	-	1.5	4.7	-	-
waterweed, Canadian	(*Elodea canadensis*)	-	-	-	-	-	-[d,e]	-	-
Rooted floating-leaved species									
American lotus	(*Nelumbo lutea*)	-	-	-	-	11.9	14.0[f]	-	5.6[g]
primrosewillow, wingleaf	(*Ludwigia decurrens*)	-	-	32.0[a,b,f]	13.0	-	-	-	-
waterlily, American white	(*Nymphaea odorata*)	-	-	-	-	4.5	4.7	-	-
Algae									
chara	(*Chara* spp.)	-	-	-	-	10.4	10.5	-	-
filamentous algae	(Chlorophycaea)	-	-	-	-	16.4[d]	8.1	16.7[d]	11.1
Frequency of submersed sites		-	-	-	43.5[a,b]	76.1	82.6[d]	94.4	100.0
Frequency of rooted floating-leaved sites		-	-	32.0[a,b,f]	13.0	16.4	18.6	-	5.6[g]
Frequency of submersed or rooted floating-leaved sites		-	-	32.0	47.8[a,b]	80.6	82.6[d]	94.4	100.0

[a]Significant increase from 1997.
[b]Reappeared after absence in 1997.
[c]Lowest record of 1991–1998.
[d]Significant decrease from 1997.
[e]Disappeared.
[f]Highest record of 1991–1998.
[g]First record.

References

Barko, J. W., and R. M. Smart. 1981. Comparative influences of light and temperature on the growth and metabolism of selected submersed freshwater macrophytes. Ecological Monographs 51(2):219–235.

Bellrose, F. C., F. L. Paveglio, and D. W. Steffeck. 1979. Waterfowl populations and the changing environment of the Illinois River valley. Illinois Natural History Survey Bulletin Volume 32, Article 1. Urbana, Illinois. 54 pp.

Fassett, N. C. 1957. A manual of aquatic plants. University of Wisconsin Press, Madison. 405 pp.

Flint, N. A., and J. D. Madsen. 1995. The effect of temperature and daylength on the germination of *Potamogeton nodosus* tubers. Journal of Freshwater Ecology 10(2):125–128.

Gleason, H. A., and A. Cronquist. 1991. A manual of vascular plants of northeastern United States and adjacent Canada. 2nd edition. The New York Botanical Garden, Bronx. 910 pp.

Green, E. W. 1947. Distribution of marsh and aquatic plants on the Upper Mississippi River Wildlife and Fish Refuge. Report, The Upper Mississippi River Wildlife and Fish Refuge, U.S. Fish and Wildlife Service, Winona, Minnesota. 132 pp.

Jessen, R., and R. Lound. 1962. An evaluation of survey techniques for submerged aquatic plants. Minnesota Department of Conservation. Game Investigational Report 6, St. Paul. 10 pp.

Madsen, J. D., and M. S. Adams. 1988. The germination of *Potamogeton pectinatus* tubers: environmental control by temperature and light. Canadian Journal of Botany 66:2523–2526.

Mills, B. H., W. C. Starrett, and F. C. Bellrose. 1966. Man's effect on the fish and wildlife of the Illinois River. Illinois Natural History Survey Biological Notes N0. 57. Urbana, Illinois. 24 pp.

Rasmussen, J. L., and J. W. Wlosinski. 1988. Operating plan of the Long Term Resource Monitoring Program for the Upper Mississippi River System. U. S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin, January 1988. EMTC 88-01. 55 pp. (NTIS # PB88 169669/AS).

Richardson, R. E. 1921. The small bottom and shore fauna of the middle and lower Illinois River and its connecting lakes, Chillicothe to Grafton: its valuations; its sources of food supply; and its relation to the fishery. Illinois State Natural History Survey bulletin 30 (5): 267–403

Rogers, S. J., and T. W. Owens. 1995. Long Term Resource Monitoring Program Procedures: Vegetation monitoring. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95–P002-3. 10 pp. + Appendixes A–E

Rogers, S., T. Blackburn, D. Dieterman, H. Langrehr, J. Nelson, and S. Romano-Peitzmeyer. 1998a. 1991 annual status report: A summary of aquatic vegetation monitoring at selected locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System. U.S. Geological Survey, Environmental Management Technical Center, Onalaska, Wisconsin, June 1998. LTRMP 98-P-005. 21 pp. + Appendixes A–B

Rogers, S., T. Blackburn, H. Langrehr, J. Nelson, and S. Romano-Peitzmeyer. 1998b. 1992 annual status report: A summary of aquatic vegetation monitoring at selected locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System. U.S. Geological Survey, Environmental Management Technical Center, Onalaska, Wisconsin, June 1998. LTRMP 98-P006. 24 pp. + Appendixes A–C

Rogers, S., T. Blackburn, K. Kruse, H. Langrehr, J. Nelson, and A. Spink. 1998c. 1993 annual status report: A summary of aquatic vegetation monitoring at selected locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System. U.S. Geological Survey, Environmental Management Technical Center, Onalaska, Wisconsin, July 1998. LTRMP 98-P007. 22 pp. + Appendixes A–B

Rogers, S., T. Blackburn, H. Langrehr, J. Nelson, and A. Spink. 1998d. 1994 annual status report: A summary of aquatic vegetation monitoring at selected locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System. U.S. Geological Survey, Environmental Management Technical Center, Onalaska, Wisconsin, July 1998. LTRMP 98-P009. 22 pp. + Appendixes A–B

U. S. Fish and Wildlife Service. 1993. Operating plan for the Upper Mississippi River System Long Term Resource Monitoring Program. Environmental Management Technical Center, Onalaska, Wisconsin, Revised September 1993. EMTC 91-P002R. 179 pp. (NTIS #PB94-160199)

Voss, E. G. 1972. Michigan Flora, I, gymnosperms and monocots. Cranbrook Institute of Science, Bloomfield Hills, Michigan. 488 pp.

Voss, E. G. 1985. Michigan Flora, II, dicots. Regents of the University of Michigan, Ann Arbor. 724 pp.

Walpole, R. E., and R. H. Myers. 1978. Probability and statistics for engineers and scientists. 2nd edition. MacMillan Publishing Co., Inc., New York. 580 pp.

Appendix A

Locations, Habitat, Number of Transects and Sites, Sampling Dates, and Distances Between Sites Sampled in Pools 4, 8, 13, and 26 of the Mississippi River and La Grange Pool of the Illinois River During the 1998 Sampling Season.

Location	Habitat	Number of transects spring:summer	Number of sites spring	Number of sites summer	Sampling dates spring	Sampling dates summer	Distance between sites (m)
Pool 4							
Mud Lake (M791.3)[a]	BWC	3:3	57	54	6/17	8/27, 9/2	30
Dead Slough Lake (M789.2, M788.5, M788.0)	BWC	9:9	134	133	6/11B12, 16	8/19, 27, 9/2	30
Goose Lake (M788.G)[b]	BWC	3:3	25	24	6/17	9/2	30
Catherine Pass (Bay City Flats[c]; M787.0)	BWC	3:3	71	74	6/16	8/27, 9/2	30
Robinson Lake (M758.R)[b]	BWC	9:9	203	218	6/1, 3B5, 10	8/18, 20, 24B25	30
Rice Lake/Big Lake Bay (M758.0, M758.5[d])	BWC	6:6	71	67	6/8, 10	8/26	30
Big Lake (M757.5)[d]	BWC	5:5	157	148	6/8, 10	8/21, 25B26	30
Upper Peterson Lake (M754.8, M754.5)	BWC	6:6	69	97	5/26B28	8/12B13	30
Lower Peterson Lake (M753.5)	BWC	4:3	130	86	5/28B29	8/17	30
Total		**48:47**	**917**	**901**	**14**	**12**	
Pool 8							
Blue Lake (M697.0)	BWI	3:3	134	132	5/26	8/10	15
Target Lake (M696.0)	BWC	11:11	290	292	5/19, 21	7/21, 29B31	15
Goose Island (M692.0)	BWC	5:5	111	115	6/2	8/11	15
Lawrence Lake (M691.0)	BWC	10:10	434	441	6/4B5, 8, 10B11	8/13B14, 19, 21, 24B25	15
Shady Maple (M690.0)	BWC	3:3	102	106	5/29	8/12	15
Horseshoe Island (M687.0)[d]	BWC	5:5	83	81	6/3	8/7	15
Boomerang Island (M686.0)[d]	IMP	4:4	104	104	5/22	8/3	15
Stoddard (M684.0)	BWI	4:4	50	50	5/27	8/4	15
Total:		**45:45**	**1308**	**1321**	**13**	**16**	

Location	Habitat	Number of transects spring:summer	Number of sites spring	Number of sites summer	Sampling dates spring	Sampling dates summer	Distance between sites (m)
Pool 13							
Brown's Lake (M545.1, M544.5)[d]	BWC	20:20	432	422	6/4B5, 8, 10B11, 17B19, 22B23	8/14, 18B21, 24B26	15
Savanna Bay (M541.5, M540.5, M539.5)	BWC	12:12	144	143	5/26B27	8/6B7, 11	15
Spring Lake (M534.8, M533.6, M532.0)	BWC	12:12	153	179	6/1B2, 4	8/11B14	15
Pomme de Terre (M526.0)	IMP	5:5	68	85	5/21	8/3	15
Potter's Marsh (M524.0)[d]	IMP	6:6	110	132	6/12, 15	8/27, 31	15
Johnson Creek Levee (M523.5)	IMP	4:4	108	114	6/16, 19	9/2B3	15
Johnson Creek (M523.0)	IMP	2:2	66	67	5/22, 26	8/5	15
Total:		**61:61**	**1081**	**1142**	**19**	**19**	
Pool 26							
Calhoun Point (I003.0)[e]	BWI	17:18	150	157	5/21, 26	8/11	15
Swan Lake (I005.5)[d]	BWI	10:10	267	292	6/2, 3	8/4	15
Stump Lake (I010.0)	BWI	8:8	169	175	5/18B19	8/6, 10	15
Fuller Lake (I011.5)	BWI	2:2	29	29	6/2	8/6	15
Total:		**37:38**	**615**	**653**	**6**	**4**	
LaGrange Pool							
Grape Island (I086.4)	MCB	3:3	16	18	6/10	8/11	15
Point Lake (I100.0)	BWI	6:6	25	23	5/22	8/4	15
Spring Lake (I135.5)	BWI	5:5	67	86	6/4, 18, 20	7/29, 31, 8/3	15
Banner Marsh (Bulrush Pond[c]; I140.0)[d]	BWI	2:2	18	18	6/5	8/7	15
Total:		**16:16**	**126**	**145**	**6**	**6**	

[a] Mississippi River miles, measured from the confluence of the Mississippi and Ohio Rivers.
[b] AG≡and AR≡to distinguish this lake from another lake with the same river mile.
[c] Locally recognized alternate name.
[d] Part of a Habitat Rehabilitation and Enhancement Project.
[e] Pool 26 is located at the confluence of the Illinois and Mississippi Rivers and the portions named here extend up the Illinois River, are managed by the Illinois Department of Natural Resources, and are designated by Illinois River miles. Illinois River miles are measured from the confluence of the Illinois and Mississippi Rivers.

Appendix B

List of Submersed and Floating-leaved Species Found During LTRMP Monitoring in Pools 4, 8, 13, and 26 of the Mississippi River and La Grange Pool of the Illinois River, 1991–1998.[a]

Family	Code	Scientific name	Common name
Azollaceae	AZME, AZCA	*Azolla* spp.[b]	watervelvet, mosquitofern
Ceratophyllaceae	CEDE4	*Ceratophyllum demersum* L.	coontail, coon=s tail
Characeae	CHAR	*Chara* spp.	chara
Characeae	NITE	*Nitella* spp.	nitella
Haloragaceae	MYSI	*Myriophyllum sibiricum* Komarov	northern watermilfoil, short spike watermilfoil
Haloragaceae	MYSP2	*M. spicatum* L.	Eurasian watermilfoil, spike watermilfoil
Hydrocharitaceae	ELCA7	*Elodea canadensis* Michx.	Canadian waterweed
Hydrocharitaceae	ELNU2	*E. nuttallii* (Planch.) St. John [c]	western waterweed
Hydrocharitaceae	VAAM3	*Vallisneria americana* Michx.	wild celery, American eelgrass
Lemnaceae	LEMI3	*Lemna minor* L.[b]	lesser duckweed, small duckweed, common duckweed
Lemnaceae	LETR	*L. trisulca* L.[b]	star duckweed
Lemnaceae	SPPO	*Spirodela polyrhiza* (L.) Schleid.[b]	greater duckweed, big duckweed, common duckweed
Lemnaceae	WOBR	*Wolffia braziliensis* Weddell[b] synonymy *W. papulifera* C. Thompson and *W. punctata* Griseb.	Brazillian watermeal
Lemnaceae	WOCO	*W. columbiana* Karst.[b]	Columbian watermeal
Lentibulariaceae	UTMA	*Utricularia macrorhiza* Le Conte, synomny *Utricularia vulgaris* L.	common bladderwort
Najadaceae	NAFL	*Najas flexilis* (Willd.) Rostkov and Schmidt	bushy pondweed, slender naiad, nodding waternymph
Najadaceae	NAGR	*N. gracillima* (A. Braun ex Engelm.) Magnus	slender waternymph
Najadaceae	NAGU	*N. guadalupensis* (Spreng.) Magnus[d]	southern waternymph
Najadaceae	NAMI	*N. minor* All.	brittle waternymph
Nymphaeaceae	NELU	*Nelumbo lutea* Willd.	American lotus
Nymphaeaceae	NULU	*Nuphar variegata* Durand synonymy *N. lutea* (L.) Sm.[e]	yellow pondlily
Nymphaeaceae	NYOD	*Nymphaea odorata* Ait. synonymy *N. tuberosa* Paine	American white waterlily
Onagraceae	LUDE4	*Ludwigia decurrens* Walt.[c]	wingleaf primrosewillow

Family	Code	Scientific name	Common name
Pontederiaceae	ZODU	*Heteranthera dubia* (Jacq.) MacM. synonymy *Zosterella dubia* (Jacq.) Small	water stargrass, grassleaf mudplantain
Potamogetonaceae	POAL8	*Potamogeton alpinus* Balbis[c]	red pondweed, alpine pondweed
Potamogetonaceae	POCR3	*P. crispus* L.	curly pondweed, curlyleaf pondweed
Potamogetonaceae	POEP2	*P. epihydrus* Raf.	ribbonleaf pondweed
Potamogetonaceae	POFO3	*P. foliosus* Raf.	leafy pondweed
Potamogetonaceae	POGR8	*P. gramineus* L.	variableleaf pondweed
Potamogetonaceae	POIL	*P. illinoensis* Morong.	Illinois pondweed
Potamogetonaceae	PONO2	*P. nodosus* Poir	river pondweed, American pondweed, longleaf pondweed
Potamogetonaceae	POPE6	*P. pectinatus* L	sago pondweed
Potamogetonaceae	POPU7	*P. pusillus* L.	small pondweed, slender pondweed
Potamogetonaceae	PORI2	*P. richardsonii* (Benn.) Rydb.	Richardson=s pondweed
Potamogetonaceae	POZO	*P. zosteriformis* Fern.	flatstem pondweed
Ranunculaceae	RAFL	*Ranunculus flabellaris* Raf.	yellow water buttercup
Ranunculaceae	RALO2	*R. longirostris* Godr.[f]	longbeak buttercup
Zannichelliaceae	ZAPA	*Zannichellia palustris* L.	horned pondweed

[a] Scientific nomenclature and common names follow the U.S. Department of Agriculture Internet PLANTS Database (1996). Common names used by Upper Mississippi River managers are also included.
[b] Species excluded from analysis.
[c] Species verified by Dr. C.B. Hellquist, North Adams State College, Massachusetts.
[d] Species verified for Pool 13 by Dr. E. Cawley, Loras College, Iowa, and for Pool 8 by Dr. C. B. Hellquist, North Adams State College, Massachusetts.
[e] Scientific nomenclature follows Gleason and Cronquist (1991). *Nuphar lutea* spp. *variegata* in PLANTS database.
[f] *Ranunculus longirostris* and *R. trichophyllus* were combined (Voss 1985).

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE June 2000	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE 1998 annual status report: Status and trend of submersed and floating-leaved aquatic vegetation in thirty-two backwaters in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

5. FUNDING NUMBERS

6. AUTHOR(S)
Yao Yin,[1] Heidi Langrehr,[2] John Nelson,[3] Theresa Blackburn,[4] Thad Cook,[5] Walter Popp[6], and Jenny Winkelman[6]

7. PERFORMING ORGANIZATION NAME AND ADDRESS
[1]U.S. Geological Survey, Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Road, La Crosse, Wisconsin, 54603
[2]Wisconsin Department of Natural Resources, 575 Lester Avenue, Onalaska, Wisconsin 54650
[3]Illinois Natural History Survey, 8450 Montclair Avenue, Brighton, Illinois 62012
[4]Iowa Department of Natural Resources, 206 Rose Street, Bellevue, Iowa 52031
[5]Illinois Natural History Survey, 704 North Schrader Avenue, Havana, Illinois 62644
[6]Minnesota Department of Natural Resources, 1801 South Oak Street, Lake City, Minnesota 55041

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Geological Survey
Upper Midwest Environmental Sciences Center
2630 Fanta Reed Road
La Crosse, Wisconsin, 54603

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
2000-P003

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Release unlimited. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (1-800-553-6847 or 703-487-4650). Also available to registered users from the Defense Technical Information Center, Attn: Help Desk, 8725 Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218 (1-800-225-3842 or 703-767-9050).

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)
Thirty-two backwaters of the Upper Mississippi and Illinois Rivers were monitored for the eighth consecutive year in 1998 to determine the status and trend of changes of submersed and floating-leaved aquatic vegetation. Aquatic vegetation was sampled at regularly spaced sites along previously established permanent transects. Species compositions, frequencies of individual species, and the frequencies of sites that supported aquatic vegetation in 1998 were calculated and compared with results from previous years. The status and trend of aquatic vegetation in 1998 varied among the thirty-two backwaters. In upper Pool 4 (above Lake Pepin), where aquatic vegetation has declined since 1991, the trend continued in 1998. In lower Pool 4 (below Lake Pepin), where aquatic vegetation declined from 1991 to 1996 and started to rebound in 1997, the rebound continued in 1998. Aquatic vegetation has increased in Pools 8 and 13 since 1994 and is at or near its best (recorded) condition since 1991. In recent years, especially since a devastating flood in 1993 and through 1998, aquatic vegetation has been rare in La Grange Pool (Illinois River) and Pool 26. In Pool 26, however, aquatic vegetation was found in all four backwaters surveyed in 1998--three of the four had no aquatic vegetation in 1997. Similarly, aquatic vegetation was found in three of the four backwaters surveyed in La Grange Pool in 1998--one of the three had no aquatic vegetation in 1997.

14. SUBJECT TERMS
Annual report, aquatic, floating-leaved, LTRMP, Mississippi River, submersed, vegetation

15. NUMBER OF PAGES
21 pp. + Appendixes A + B

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	